10/580531

New U.S. National Stage of PCT/EP2004/053097
Filed May 25, 2006

IAP20 Rec'd PCT/PTO 25 MAY 2006

CLEAN COPY OF SUBSTITUTE SPECIFICATION

COMPOSITE ABRASIVE BODIES

[0001] This is a U.S. National Stage of Application No. PCT/EP2004/053097, filed November 25, 2004, which claims the benefit of European Patent Application No. 03027086.2, filed November 25, 2003. The disclosure of the prior applications is hereby incorporated by reference herein in their entireties.

[0002] Technical Field

[0003] This disclosure relates to fabrication of composite abrasive bodies.

[0004] Prior Art

[0005] Abrasive products have been used for a long time for machining materials. Abrasive products consist of, *inter alia*, abradant granular particles that are fixed to a backing material by means of a binder.

[0006] DE 198 53 550 C1 describes an abrasive flap disc in which abrasive grains are dispersed on a base bonding coat that is applied to a backing.

[0007] US 5,722,881 describes use of epoxies for bonding abrasive flaps to an abrasive wheel.

[0008] Epoxy adhesives have the disadvantage that they either have very long curing times or must be cured by heat. As a result, long holding times and/or high energy costs for curing are required for efficient mass production, which means increased costs for the production process.

SUMMARY

[0009] Therefore, an aim of the present disclosure is to provide composite abrasive bodies that can be produced in such a way that avoids the disadvantages of the prior art.

[0010] This disclosure provides novel composite abrasive bodies, as well as methods for their preparation and use.

[0011] The novel composite abrasive bodies of embodiments may overcome the disadvantages of the prior art by the use of a two-component polyurethane or (meth)acrylate adhesive. Two-component polyurethane or (meth)acrylate adhesives cure extremely rapidly and in particular enable rapid bonding even at room temperature. This enables fast working times and energy-saving industrial mass production of these composite abrasive bodies.

[0012] These and other features and advantages of various embodiments of materials, devices, systems and/or methods are described in or are apparent from, the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Exemplary embodiments of the composite abrasive bodies and methods of preparing and using composite abrasive bodies are explained in more detail below with the help of the drawings. The same reference numbers are assigned to the same elements in the different figures. Force directions are indicated by arrows. These figures are intended to be illustrative and non-limiting; thus, only those elements essential for direct understanding of the disclosed composite abrasive bodies and methods for preparing and using composite abrasive bodies are shown.

[0014] Figures 1a-c) are partial schematic cross sectional views through an embodiment of an abrasive product support/abrasive product/adhesive assembly of this disclosure. In particular:

[0015] Figure 1a) is a partial cross sectional view showing an abrasive product bonded to an abrasive product support along a longitudinal surface,

[0016] Figure 1b) is a partial cross sectional view showing an abrasive product bonded to an abrasive product support along a transverse edge, and

[0017] Figure 1c) is a partial cross sectional view showing a possible design for an embodiment of an abrasive product;

[0018] Figure 2 is a schematic view of an abrasive flap disc of an embodiment of the disclosure.

[0019] Figure 3 is a partial schematic cross sectional view of the abrasive flap disc shown in Figure 2, taken along the line *AA*.

[0020] Figure 4 is a schematic view of a grinding machine with abrasive flap disc of an embodiment of the disclosure.

[0021] Figure 5 is a schematic view of an abrasive flap wheel of an embodiment of the disclosure.

[0022] Figure 6 is a partial schematic cross sectional view of the abrasive flap wheel shown in Fig. 5, taken along the line *BB*.

[0023] Figure 7 is a schematic view of a grinding machine with abrasive flap wheel of an embodiment of the disclosure.

[0024] Figures 8a) and b) are partial schematic cross sectional views through a composite abrasive body to illustrate its fabrication. In particular:

[0025] Figure 8a) is a partial schematic cross sectional view showing a composite abrasive body including inserted abrasive products, and

[0026] Figure 8b) is a partial schematic cross sectional view showing a composite abrasive body in which the abrasive products have been tilted.

DETAILED DESCRIPTION OF EMBODIMENTS

[0027] The present disclosure relates, in exemplary embodiments, to a composite abrasive body including at least one abrasive product support, at least one abrasive product, as well as at least one cured two-component polyurethane or (meth)acrylate adhesive bonding the abrasive product support and the abrasive product to each other. Abrasive particles may also be present on the surface of the abrasive product.

[0028] Herein, the term "(meth)acrylate" refers to acrylic acid esters and methacrylic acid esters.

[0029] The present disclosure also relates, in exemplary embodiments, to the use of a two-component (meth)acrylate adhesive in the fabrication of composite abrasive bodies. The two-component (meth)acrylate adhesive includes a first component that contains at least one (meth)acrylate monomer and a second component that contains at least one radical initiator. The two-component (meth)acrylate adhesive may be used to bond the abrasive product support and the abrasive product together.

[0030] The present disclosure also relates, in exemplary embodiments, to the use of a two-component polyurethane adhesive in the fabrication of composite abrasive bodies. The two-component polyurethane adhesive includes a first component that contains at least one polyamine or one polyol and a second component that contains at least one polyisocyanate. The two-component polyurethane adhesive may be used to bond the abrasive product support and the abrasive product together.

[0031] In addition, the present disclosure relates, in exemplary embodiments, to methods for fabricating composite abrasive bodies. These methods include mixing of the two components of a two-component polyurethane or (meth)acrylate adhesive, applying the mixed adhesive to the abrasive product support, bringing the mixed adhesive into contact with at least one abrasive product, and curing the adhesive.

[0032] Figures 1a-b) are partial schematic cross sectional views of a composite abrasive body according to exemplary embodiments. The illustrated composite abrasive body comprises an abrasive product support 1 that is bonded to an abrasive product 2 by means of a two-component (meth)acrylate or polyurethane adhesive 4. The abrasive product may be bonded along the large-area surface (Figure 1a) or at or around its transverse edge (Figure 1b).

[0033] Abrasive particles may be present on the surface of the abrasive product. Abrasive particles for use in embodiments may be made from materials such as are known to the person skilled in the art in this field. For example, abrasive particles may be prepared from natural or synthetic materials such as emery, garnet, flint, quartz, corundum, potassium fluoroborate, cryolite, chiolite, diamond, silicon carbide, cubic boron nitride (CBN), or the like. It is additionally known that these particles may be present in different grain sizes and grain shapes. The person skilled in the art may select suitable material or materials in the respectively suitable grain size or mix of grain sizes in the respectively optimal grain shape, depending on the specific grinding problem. The abrasive product of embodiments may have these abrasive particles over the entire surface or only in certain areas. However, in particular embodiments, the abrasive particles may be present only on one side of the abrasive product. such as in Figure 1c.

[0034] In some embodiments, the abrasive product may be in the form of a flap-shaped abrasive member.

[0035] The abrasive product, or the flap-shaped abrasive member, of embodiments may be designed in very different ways. In some embodiments, the abrasive product may consist of a rigid material and abrasive particles, for example, as can be fabricated by a casting or sintering process from metal, duromers or reactive resins, optionally by dispersing the abrasive particles on the rigid material or by rolling the abrasive particles into the rigid material.

[0036] In other embodiments, the abrasive product may be constructed from at least one cloth or paper 101, at least one binder 102, as well as abrasive particles 3, as shown schematically in Figure 1c. In such embodiments, the closth may be a crossply or knit fabric. Fibers used for the cloth in exemplary embodiments may include carbon, glass, nylon, aramid, cotton, or polyester fibers as well as mixtures thereof.

[0037] Various polymeric synthetic resins may be used as a binder for embedding the abrasive particles in the cloth or paper material. For example, suitable binders include the reaction products based on polyepoxides, poly(meth)acrylates, or polyurethanes, as well as binders based on phenol—formaldehyde resins or polyimides and two-component (meth)acrylate or polyurethane adhesives, such as those used to bind the abrasive product to the abrasive product support, and the unfilled reactive components on which these two-component (meth)acrylate or polyurethane adhesives are based.

[0038] In embodiments in which the abrasive product includes a cloth, crossply, or knit fabric, the binder can penetrate between the fibers, and may completely surround cloth, crossply, or knit fabric, and the binder may not be presenton only one side of the cloth, crossply or knit fabric, as shown in Figure 1c. The abrasive particles may also be surrounded by cloth, crossply, or knit fabric or their fibers, and not only by the binder.

[0039] In certain embodiments, the abrasive particles may be embedded in the binder, i.e., partially surrounded by binder, where part of the surface of the abrasive particles is free.

[0040] In addition to the binder, optionally a size coat may also be used in embodiments. Such a size coat may be applied over the binder, for example, to protect the binder from outside influences.

[0041] The abrasive product support may play the role of a carrier for abrasive products in embodiments. The abrasive product support, in exemplary embodiments, may be connected to a machine, such as by clamping forces, so that the abrasive product contacts the material to be abraded by means of rotary or shearing motions, and thus the material removal operation is accomplished.

[0042] The abrasive product support of exemplary embodiments may be made either from a rigid material, such as metal or duromer plastics, or from an elastic material. Elastic materials may be easily adjusted to fit the contours of the workpieces to be abraded, and thus are suitable for fine grinding operations or for workpieces with complex surface geometries. However, elastic abrasive product supports may have lower mechanical load bearing capacities as well as the reduced lifetimes.

[0043] Rigid materials may be used in some embodiments as abrasive product supports and have higher mechanical load bearing capacities than elastic materials. However,

rigid materials are difficult to use for grinding operations on workpieces that have mostly non-planar surfaces.

[0044] The abrasive product support of exemplary embodiments may be a circular disc, a wheel, or a belt. In some embodiments, the abrasive product may be bonded to the abrasive product support on the largest area surface of the disc or wheel or belt, such as in the radial direction of the disc or wheel.

[0045] In some embodiments, the abrasive product may be bonded to the abrasive product support on the peripheral surface of the wheel or circular disc, such as in a radial orientation.

[0046] The adhesive used to bond the abrasive product support and the abrasive product in embodiments may be a two-component polyurethane or (meth)acrylate adhesive. The adhesive reacts very fast even at room temperature. However, the adhesive may also be cured at higher temperatures. The adhesive may be cured, in particular embodiments, at a temperature between 10°C and 180°C, such as between 20°C and 80°C, between 20°C and 40°C, or at room temperature. However, in particular for the two-component (meth)acrylate adhesive, it is advisable for safety reasons to use higher temperatures during application and curing.

[0047] In embodiments in which the adhesive is a two-component (meth)acrylate adhesive, the first component includes at least one (meth)acrylate monomer. Monofunctional, difunctional, trifunctional, tetrafunctional, and pentafunctional (meth)acrylate monomers are suitable. Particularly suitable (meth)acrylate monomers include methyl methacrylate, isobornyl (meth)acrylate, cyclohexyl (meth)acrylate, *t*-butyl (meth)acrylate, tetrahydrofurfuryl (meth)acrylate, dicyclopentadienyl (meth)acrylate, dicyclopentadienyloxyethyl (meth)acrylate, ethylene glycol di(meth)acrylate, di-, tri-, tetraethylene glycol di(meth)acrylate, propylene glycol di(meth)acrylate, di-, tri-, tetrapropylene glycol di(meth)acrylate, butanediol di(meth)acrylate, hexanediol di(meth)acrylate, epoxy (meth)acrylate (in particular as can be synthesized from (meth)acrylic acid and bisphenol-A diglycidyl ether, bisphenol-A diglycidyl ether oligomers, bisphenol-A or ethoxylated bisphenol-A), trimethylol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol penta(meth)acrylate, as well as mixtures of these monomers.

[0048] The (meth)acrylate monomers used in some embodiments may have glass transition temperatures above 55°C.

[0049] Under certain circumstances and in certain embodiments, methyl methacrylate may be selected as the (meth)acrylate monomer. For example, methyl methacrylate may be used in embodiments in which the intense odor of this monomer is not a problem. However, odorless monomers or monomers with only a slight odor may also be used in exemplary embodiments.

[0050] The first component of the two-component (meth)acrylate adhesive of embodiments may include at least one monomer selected from the group including isobornyl (meth)acrylate, tetrahydrofurfuryl (meth)acrylate, diethylene glycol di(meth)acrylate, epoxy (meth)acrylate (in particular as can be synthesized from (meth)acrylic acid and bisphenol-A diglycidyl ether, bisphenol-A diglycidyl ether oligomers, bisphenol-A or ethoxylated bisphenol-A), trimethylol tri(meth)acrylate, as well as mixtures thereof.

[0051] Methacrylates are particularly useful as monomers of the first component of embodiments.

[0052] In embodiments, the second component of the two-component (meth)acrylate adhesive may include at least one radical initiator. All radical initiators known to the person skilled in the art in the field of (meth)acrylate adhesives are suitable as the radical initiator. Both thermal and photochemical radical initiators can be used. In particular embodiments, the radical initiator is a peroxide, including organic peroxides such as benzoyl peroxide.

[0053] Two-component (meth)acrylate adhesives of the SikaFast® series (commercially available from Sika Schweiz AG, Zürich) and those disclosed in WO 02/070620, which is incorporated herein by reference in its entirety, may be particularly suitable for use in certain embodiments.

[0054] In addition, a photochemically cured one-component (meth)acrylate adhesive may be used as the adhesive of embodiments, instead of a two-component (meth)acrylate adhesive. Photochemical curing is achieved by exposure to a light source, in particular a high-pressure mercury lamp or a laser. However, such embodiments require a light source for curing, and this may be undesirable for certain embodiments in which the adhesive area may be shaded.

[0055] In embodiments in which the adhesive is a two-component polyurethane adhesive, the first component of the adhesive may include at least one polyol or one polyamine and the second component may include at least one polyisocyanate.

[0056] A polyamine is a molecule with two or more amine functional groups, such as primary amine groups. Examples of polyamines that may be suitable for use in embodiments are aliphatic polyamines such as ethylenediamine, 1,2- and 1,3-propanediamine, 2-methyl-1,2-propanediamine, 2,2-dimethyl-1,3-propanediamine, 1,3- and 1,4-butanediamine, 1,3- and 1,5-pentanediamine, 1,6-hexanediamine, 2,2,4- and 2,4,4-trimethylhexamethylenediamine and mixtures thereof, 1,7-heptanediamine, 1,8-octanediamine, 4-Aminomethyl-1,8-octanediamine, 1,9-nonanediamine, 1,10-decanediamine, 1,11-undecanediamine, 1,12-dodecanediamine, methyl bis(3-aminopropyl)amine, 1,5-diamino-2-methylpentane (MPMD), 1,3-diaminopentane (DAMP), 2,5-dimethyl-1,6-hexamethylenediamine, cycloaliphatic polyamines such as 1,3- and 1,4-diaminocyclohexane, bis(4-aminocyclohexyl)methane, bis-(4-amino-3-methylcyclohexyl)methane, bis(4-amino-3-ethylcyclohexyl)methane, bis(4-amino-3,5-dimethylcyclohexyl)methane, 1-amino-3-aminomethyl-3,5,5-trimethylcyclohexane (= isophoronediamine or IPDA), 2- and 4-methyl-1,3-diaminocyclohexane and mixtures thereof, 1,3- and 1,4-bis(aminomethyl)cyclohexane, 1-cyclohexylamino-3-aminopropane, 2,5(2,6)-bis(aminomethyl)bicyclo[2.2.1]heptane (NBDA, manufactured by Mitsui Chemicals), 3(4),8(9)-bis(aminomethyl)tricyclo[5.2.1.0^{2,6}]decane, 3,9-bis(3-aminopropyl)-2,4,8,10-tetraoxaspiro[5.5]undecane, 1,3- and 1,4-xylylenediamine, ether group-containing aliphatic polyamines such as bis(2-aminoethyl) ether, 4,7-dioxadecane-1,10-diamine, 4,9-dioxadodecane-1,12-diamine and higher oligomers thereof, polyoxyalkylene polyamines with theoretically two or three amino groups, for example as can be obtained under the name Jeffamine® (manufactured by Huntsman Chemicals), aromatic amines such as, for example, 3,5-diethyl-2,4(2,6)-diaminotoluene (Lonzacure DETDA®), 3,5-dimethylthiotoluylenediamine (Ethacure 300®), 4,4'-methylene-bis(2,6-diethylaniline) (MDEA), 4,4'-methylene-bis(3-chloro-2,6-diethylaniline) (MCDEA), as well as mixtures of the aforementioned polyamines.

[0057] A polyol is a molecule with two or more hydroxy functional groups. For example, the following commercially available polyols or any mixtures thereof can be used in exemplary embodiments:

[0058] -polyoxyalkylene polyols, also called polyether polyols, which are the polymerization product of ethylene oxide, 1,2-propylene oxide, 1,2- or 2,3-butylene oxide, tetrahydrofuran or mixtures thereof, optionally polymerized using an initiator molecule with two or three active H atoms such as, for example, water or compounds with two or three OH

groups and/or NH_2 groups. Polyoxyalkylene polyols that may be used include those having a low degree of unsaturation (measured according to ASTM D-2849-69 and expressed in milliequivalents of unsaturation per gram polyol (meq/g)), synthesized for example using "double metal cyanide complex catalysts" (DMC catalysts for short), as well as polyoxyalkylene polyols with a higher degree of unsaturation, synthesized for example using anionic catalysts such as NaOH, KOH, or alkali metal alkoxides. Polyoxyalkylene diols and triols that may be particularly suitable for use in embodiments are those that have a degree of unsaturation below 0.02 meq/g and a molecular weight in the range from 1000 to 30 000 g/mol, polyoxypropylene diols and triols with a molecular weight from 400 to 8000 g/mol, as well as "EO-endcapped" (ethylene oxide-endcapped) polyoxypropylene diols or triols. The latter are special polyoxypropylene polyoxyethylene polyols, that can be obtained, for example, by alkoxylating pure polyoxypropylene polyols with ethylene oxide, after completion of polypropoxylation, and thus have primary hydroxyl groups. Herein, the term "molecular weight" refers to the average molecular weight M_w.

[0059] -polyhydroxy-terminated polybutadiene polyols;

[0060] -polyester polyols, synthesized for example from dihydric or trihydric alcohols such as, for example, 1,2-ethanediol, diethylene glycol, 1,2-propanediol, dipropylene glycol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, neopentyl glycol, glycerol, 1,1,1-trimethylolpropane or mixtures of the aforementioned alcohols, with organic dicarboxylic acids or their anhydrides or esters such as, for example, succinic acid, glutaric acid, adipic acid, suberic acid, sebacic acid, dodecanedicarboxylic acid, maleic acid, fumaric acid, phthalic acid, isophthalic acid, terephthalic acid, and hexahydrophthalic acid or mixtures of the aforementioned acids, as well as polyester polyols derived from lactones such as, for example, ε-caprolactone;

[0061] -polyether polyols or polyester polyols synthesized from tetrahydric or polyhydric alcohols such as pentaerythritol, sorbitol, mannitol, and other sugar-based alcohols.

[0062] -polycarbonate polyols, as can be obtained, for example, by reaction of the above-indicated alcohols (used to synthesize the polyester polyols) with dialkyl carbonates, diaryl carbonates, or phosgene.

[0063] In embodiments, the above-indicated polyols may have an average molecular weight from 250 to 30 000 g/mol and an average number of OH functional groups in the range from 1.6 to 3.

[0064] In addition to the above-indicated polyols, the following can be used as the first component of embodiments: low molecular weight compounds with two or more hydroxyl groups such as, for example, 1,2-ethanediol, 1,2- and 1,3-propanediol, neopentyl glycol, diethylene glycol, triethylene glycol, the isomeric dipropylene glycols and tripropylene glycols, the isomeric butanediols, pentanediols, hexanediols, heptanediols, octanediols, nonanediols, decanediols, and undecanediols, 1,3- and 1,4-cyclohexanedimethanol, hydrogenated bisphenol A, 1,1,1-trimethylolethane, 1,1,1-trimethylolpropane, glycerol and sugar alcohols and other alcohols with a high number of OH groups.

[0065] A polyisocyanate is a molecule with two or more isocyanate groups. In embodiments, the second component of the adhesive may be a polyurethane prepolymer that can be synthesized from polyisocyanates, in particular selected from the group including 1,6-hexamethylene diisocyanate (HDI), 2,4- and 2,6-toluylene diisocyanate (TDI), 4,4'-diphenylmethane diisocyanate (MDI), 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethylcyclohexane (= isophorone diisocyanate or IPDI), their isomers, their polymers, as well as their mixtures, and polyols, including those polyols set forth above, such as polyoxyalkylene polyols.

[0066] Two-component polyurethane adhesives of the SikaForce® series (commercially available from Sika Schweiz AG, Zürich) may be especially suitable for use in embodiments.

[0067] The early strength (at least until achievement of early strength high enough to permit transport of the composite abrasive body) of a two-component polyurethane or (meth)acrylate adhesive at room temperature may be achieved, in some embodiments, within less than 30 minutes, such as within less than 10 minutes, as measured from the time the two components are mixed. In specific embodiments, an early strength achieved within less than 5 minutes may be achieved.

[0068] Two-component polyurethane or (meth)acrylate adhesives of embodiments additionally may provide potlifes at room temperature of less than 20 minutes, in particular embodiments, of less than 10 minutes. In specific embodiments, a potlife of less than 5 minutes may be obtained.

[0069] Two-component (meth)acrylate adhesives are used as the adhesives of certain embodiments, because this type of adhesive provides extremely favorable curing behavior. As a result of the radical polymerization mechanism, the viscosity of the adhesive abruptly increases considerably only at the very end of the open time, so the adhesive can be easily worked to practically the same extent throughout the time between mixing and this rise in viscosity at the end of the open time. This is not the case for addition polymerization, as occurs for two-component polyurethane adhesives, which may be used in other embodiments. In embodiments in which the adhesive is a two-component polyurethane adhesive, the viscosity rises steadily after mixing, so the handling properties change considerably even before the end of the potlife. (Meth)acrylate adhesives are likewise advantageously used in some embodiments, because they reach final strength faster.

[0070] In embodiments, the two-component (meth)acrylate or polyurethane adhesive may display thixotropic behavior. Such thixotropic properties can be induced chemically or physically. In embodiments, the adhesive may have a pasty consistency. Thixotropy or a pasty consistency is especially advantageous for some embodiments because the effect is that an abrasive product inserted into the adhesive is held in this position at least long enough for the adhesive to become sufficiently crosslinked that the adhesive has enough strength to hold the abrasive product in position. Thixotropy is especially useful in certain embodiments, because the thixotropic behavior allows the abrasive product to be easily inserted into the adhesive and held in position, without its own weight making the abrasive product tip over in an uncontrolled manner.

[0071] A two-component (meth)acrylate or polyurethane adhesive can also, as needed in embodiments, contain other components such as fillers, drying agents, catalysts, thixotropic agents, additives such as adhesion promoters, light stabilizers, defoamers, flow-control agents, and impact strength modifiers. Persons skilled in the art will use their expertise in using such additives, and will use them respectively in one or both components.

[0072] Figure 2 depicts an abrasive flap disc 9, which represents one embodiment of a composite abrasive body. Here, the abrasive products 2 are flap-shaped abrasive members that are disposed on abrasive product support 1, partially overlapping each other in a fan-like manner, and are bonded to abrasive product support 1 by means of a two-component (meth)acrylate or polyurethane adhesive.

[0073] This structure also can be described as a shingle-like arrangement of abrasive flaps. Abrasive product support 1 here has the shape of a circular disc. The disc may have a hole 5 in the center, through which a mandrel 7 may be inserted. Abrasive product support 1 also may have a reinforcing ring 6.

[0074] Figure 3 depicts a partial cross section along line *AA* of Figure 2, through the peripheral area of abrasive flap disc 9 and shows abrasive products 2, partially overlapping in a shingle-like fashion, with abrasive particles 3 on their surfaces. The abrasive products are joined to abrasive product support 1 with polyurethane or (meth)acrylate adhesive 4.

[0075] Figure 4 depicts a view of a grinding machine 8 with abrasive flap disc 9 connected by means of mandrel 7, which is inserted through hole 5. The abrasive flap disc has abrasive products 2 radially bonded to disc-shaped abrasive product support 1.

[0076] Figure 5 depicts an abrasive flap wheel 12, which represents another embodiment of a composite abrasive body. Here, the abrasive products 2 are flap-shaped abrasive members disposed on abrasive product support 1, partially overlapping each other, and are bonded to abrasive product support 1 by means of a two-component (meth)acrylate or polyurethane adhesive 4. Abrasive products 2 in this embodiment are on the peripheral surface of the abrasive flap wheel. The abrasive flap wheel may have a hole at the centerline point and optionally a nut 10 with thread 11 on the inside of the nut. The abrasive flap wheel also may have a reinforcing ring 6.

[0077] Figure 6 depicts a partial cross section along line *BB* of Figure 5, through the peripheral area of abrasive flap wheel 12 and shows abrasive products 2, partially overlapping in a shingle-like fashion, with abrasive particles 3 on their surfaces. The abrasive products are joined to abrasive product support 1 with a polyurethane or (meth)acrylate adhesive 4.

[0078] Figure 7 depicts a schematic view of a grinder 13 with an abrasive flap wheel 12.

[0079] Another embodiment of a composite abrasive body is an arrangement in which the abrasive product support 1 is a wheel and abrasive products 2, such as flap-shaped abrasive products that stick out radially on the peripheral surface of the wheel in the vertical direction relative to the peripheral surface, are bonded with a two-component polyurethane or (meth)acrylate adhesive.

[0080] Another embodiment of a composite abrasive body is an abrasive belt. Here, the abrasive product is bonded flat against an abrasive product support using two-component polyurethane or (meth)acrylate adhesive. The abrasive belt can be a sheet or an endless belt.

[0081] The present disclosure also includes embodiments directed to methods for fabrication of a composite abrasive body.

[0082] The method of embodiments includes at least the steps described below. The two components of a two-component polyurethane or (meth)acrylate adhesive are mixed with each other. This operation may be carried out with conventional mixing devices, such as by means of a static mixer. Then, the mixed adhesive may be applied to the abrasive product support, such as in the form of an adhesive bead. This operation may be done where the abrasive products are to be joined to the abrasive product support, for example in the peripheral areas of a disc or a wheel. Then, the mixed adhesive may be brought into contact with at least one abrasive product before the potlife of the adhesive has elapsed.

[0083] This contact should, in embodiments, be made in such a way that the abrasive product, which may be a flap-shaped abrasive member, may be inserted into the mixed uncured adhesive, which is applied to the abrasive product support, essentially vertically with respect to the abrasive product support surface, so that part of the surface is covered by adhesive. Such an arrangement is depicted schematically in Figure 8a). Finally, the adhesive is cured.

[0084] One more step, involving tilting the abrasive products, may be performed between bringing the abrasive products into contact with the mixed adhesive and curing of the adhesive. In such embodiments, the abrasive products, inserted next to each other in the uncured adhesive, may be taken from an essentially vertical orientation to a tilted orientation in a controlled manner. Thus a fan-like or shingle-like partial overlapping of the abrasive products is achieved, as shown schematically in Figure 8. This is achieved, in particular embodiments, by means of a tangential force that may be exerted on the abrasive products on the side opposite the adhesive, as is shown schematically in Figure 8a.

[0085] The abrasive products of some embodiments may be tilted only after all the abrasive products have been brought into contact with the adhesive.

[0086] In the case of fabrication of an abrasive flap disc 9, this tilting of the flap-shaped abrasive members may be achieved by means of a combination rotational and pushing motion of a body touching the free edge of the upright flap-shaped abrasive members.

[0087] In some embodiments, it may be advantageous for the surface of the abrasive product support and/or the abrasive product to undergo chemical or physical pretreatment before bonding. Such pretreatment may involve, for example, grinding, brushing, sand blasting, treatment with cleaning agents, adhesion promoter solutions, or primers. Such treatments may, for example, result in better adhesion and thus lead to greater safety and/or load bearing capacity of the abrasive composite.

[0088] The steps of mixing, applying, bringing into contact, and curing the adhesive may be carried out at a temperature between 10°C and 180°C, such as between 20°C and 80°C, or between 20°C and 40°C. These steps may also be performed at room temperature.

[0089] The above-described method may be especially useful if the adhesive used exhibits thixotropic behavior and/or has a pasty consistency.